

REVIEW ON PHYCHEMISTRY AND PHARMACOLOGICAL ASPECTS OF BACOPA MONNIERI (BRAHMI) (FAMILY: SCROPHULARIACEAE)

Prajakta Gunjal*¹, Vishakha Shingote*², Komal Hase*³, Savita Korde*⁴

*¹Vidya Niketan Institute Of Pharmacy And Research Center, Bota, Tal- Sangamner,
Dist-Ahmednagar, Maharashtra 422602, India.

*^{2,3,4}Department Of Pharmacology Vidya Niketan Institute Of Pharmacy And Research Center, Bota,
Tal- Sangamner, Dist- Ahmednagar, Maharashtra 422602, India.

ABSTRACT

One of the earliest forms of traditional ayurvedic medicine in India is bacopa monnieri (Brahmi). It was developed more than 300 years ago in India. It is an annual creeping plant that can be found in marshy, moist, and damp environments. It is a member of the Scrophulariaceae family. Through numerous studies, the principal chemical medicinal constituents of this plant have been identified as triterpenoids, saponins, and bacosides. It has been discovered that bacoside A and bacoside B are the primary components generating therapeutic advantages. A, B, C, D, mannitol, and glutamic acid are saponins. This review focuses on studies that have identified the pharmacological and phytochemical properties of the plant Bacopa monnieri. These properties include those that are anti-depressant, anti-inflammatory, anti-oxidative, anti-fungal, anti-epileptic, anti-convulsant, anti-ulcerative, anti-microbial, anti-diabetic, and anti-cancer, among many others.

Keywords: Bacopa Monnieri, Introduction, Pharmacological Activity, Plant Description, And Morphology System, Rasayan, Extract.

I. INTRODUCTION

Brahmi is a well-known hypotensive, neuropathic sedative, and booster of intelligence. It is a strong tonic used to treat sleeplessness as well as increase mental alertness, learning capacity, and memory. Bacopa monnieri is known as Brahmi in Indian and Hindi, as well as Rau Dang, Herpestis monnieri, water hyssop, and the "herb of grace" in Vietnamese. Brahmi was given its name in honor of Lord Brahma, who is widely mentioned in religious, social, and medicinal writings in India as the mythical creator of the world and the founder of the science of Ayurveda.

The active constituents of Bacopa monnieri's (EBM) Brahmi extract include a variety of triterpenoids, alkaloids, glycosides, phytochemicals, sapogenin, Brahmic acid, brahmoside, brahminoside, and isobrahmic acid. A significant therapeutic plant from the Plantaginaceae family is Bacopa monnieri. It is a creeping, perennial plant that is native to the marshes of South and East Asia, Australia, Europe, Africa, North and South America, and Australia. "Lord Brahma" or "Brahman" is the source of the Sanskrit word "Brahmi. The Hindu term for the collective consciousness is Brahman, and Lord Brahma is the divinity responsible for all of the world's creative energies. Literally, Brahmi refers to Brahma's energy ("Shakti").

Since the sixth century AD, the herb has been mentioned in numerous ancient Ayurvedic treatises, such as the "Charaka Samhita," where it is advised for use in formulations for the management of a variety of mental conditions, such as anxiety, poor cognition, and lack of concentration, as well as as a diuretic and an energizer for the nervous system and the heart. According to significant research, the brahmi plant possesses nootropic properties and can enhance cognition and respiratory function. B. monnieri showed promise in treating dementia and age-related cognitive decline in animal studies [9, 10]. Research into the cognitive decline of older people was furthered as a result of these discoveries, and it was shown that B. monnieri significantly improved cortical functioning.



Fig 1. Picture of (Brahmi) *Bacopa monnieri* plant

SYNONYMS –

1. *Bacopa monniera* Hayata & Matsum.
2. *Bramia monnieri* (L.) Pennell
3. *Gratiola monniera* L.
4. *Herpestes monniera* (L.) Kunth
5. *Herpestis fauriei* H.Lev.
6. *Herpestis monniera*
7. *Herpestris monniera*
8. *Lysimachia monnieri* L.
9. *Moniera cuneifolia* Michx.
10. *Capraria monnieri* (L.)L

BOTANICAL/SCIENTIFIC CLASSIFICATION

Botanical Name – *Bacopa monnieri*

Family – Plantaginaceae

Sub Family Scrophulariaceae

Kingdom –Plantae

Clade - Angiosperms

Clade – Asterids

Clade – Eudicots

Division – Tracheophyta

Class Magoliopsida

Order – Lamiales

Genus –*Bacopa*

Species *Bacopa monnieri* (L.)

VERNACULAR NAME –

Chinese name: Jia-ma-chi-xian

Sinhala name: Lunuwila

Tamil name: Neera brahmi

Kannada name: Jala brahmi

Telugu name: Sambarenu

Bengali name: Birami

Hindi name: Brahmi

English name: Thyme leaved gratiola, water hyssop, Indian pennywort, Herb of Grace

Latin name: Bacopa monnieri

Sanskrit name: Bramhi, Tikalonika

Gujarati: Baam, Jalanevari

Marathi: Brahmi, Jalabrahmi

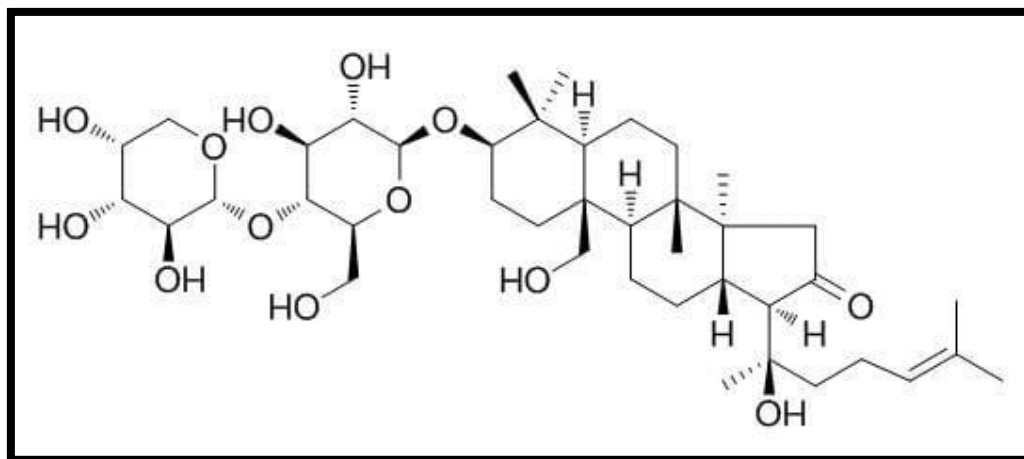
Malayam: Brahmi

PHYTOCHEMICALS COMPONENT -

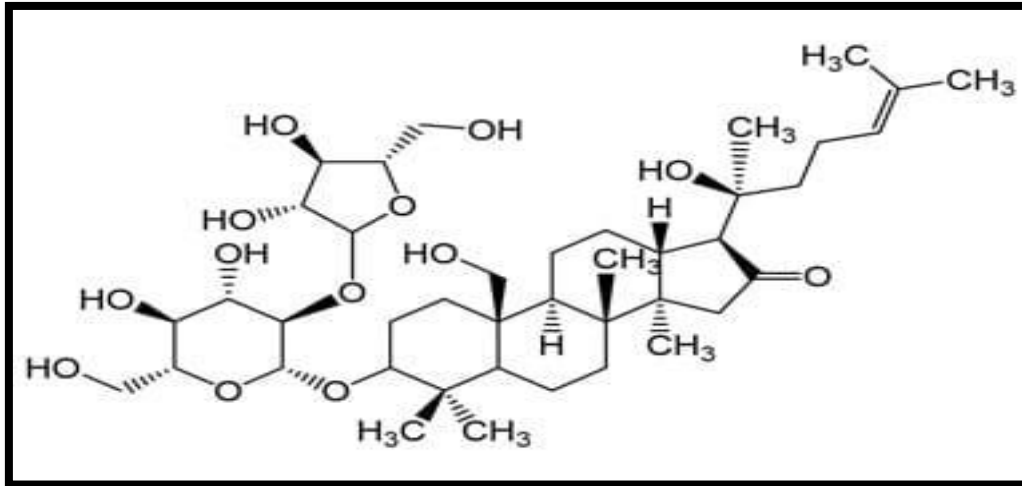
B. monnieri contains alkaloid brahmine, nicotinine, herpestine, bacosides A and B, saponins A, B and C, triterpenoid saponins, stigmastanol, β -sitosterol, betulinic acid, D-mannitol, stigmasterol, α -alanine, aspartic acid, glutamic acid, and serine and pseudojубogenin glycoside .

Table No. 1: Active constituents of Bacopa monnieri

Chemical groups	Content
Saponins	Bacoside A, Bacoside B, bacosasaponnins, D-mannitol, acid A, monnierin
Flavonoids	Apigenin, luteonin
Alkaloids	Brahmine, herpestine, hydrocotyline
Glycosides	Adiaticoside, thanakunicide
Sapogenin	Jубacogenin, pseudojубacogenin
Phytochemicals	Betulinic acid, betulic acid, wogonin, Oroxindin, stigmastarol, B-sitosterol
Others constituents	Brahmic acid, brahmoside, brahminoside, isobrahmic Acid.



Bacoside A (Levorotatory)



Bacoside B(dextrorotary)

Fig No. 2. chemical structure of some well-known Saponins from Bacopa monnieri

Table No.2: Chemical Composition Of Bacopa Monnieri (Brahmi)

Sr. no	Components	Amount (/100mg)
1.	Moisture	88.4 gm
2.	Protein	2.1 gm
3.	Fat	0.6 gm
4.	Carbohydrates	5.9 gm
5.	Crude fibre	1.05 gm
6.	Ash	1.9 gm
7.	Calcium	202.0 gm
8.	Phosphorus	16.0 gm
9.	Ascorbic acid	63.0 gm
10.	Nicotinic acid	0.3 gm
11.	Iron	7.8 gm
12.	Energy	38 cal

ORGANOLEPTIC PROPERTIES

Color: Leaves are green in color and flower is bluish white in color

Odour: Characteristic

Taste: Bitter

Size: Leaves are about 2cm

Seed: minute and numerous

It is Leaves about 2cm and its color is green.

It is flower is stalked, solitary, corolla is bluish white in colour and above 1cm in size Which present the 4to 5 petals.

It is Leaves are flashy, obovate ,alternate, simple, entire, with broad apex, sessile and Lower surface is dotted in shape.

MORPHOLOGY OF BACOPA MONNIERI

HABIT: It is a short, glabrous succulent that creeps. It has ascending branches that are 20 cm or longer. It covers the earth.

STEM -10-30 cm long, rooting at the nodes, Branches numerous, ascending.

LEAVES: Sessile, decussate, 6-25 by 2.5- 10 mm, Obovate- Oblong or Spathulate, rather fleshy, dotted with black specks, very Obtuse, quite entire; nerves obscure.

FLOWERS: Solitary, Axillary, Bracteoles 5 Mm long, linear; pedicles 0.6-3.2 cm Long, slender.

CALYX: Globous, divided to base; upper Sepals 6 by 3-4mm, ovate, acute; the other 4 Sepals slightly shorter than upper; **the** 2 inner lateral ones 1.5 mm wide, lanceolate, Acute.

COROLLA: Pale blue or white, 8 mm long Lobes nearly equal, rounded , strangled when Fresh with shining dots.

ANTHERS – Bluish Purple; **POLLEN** – White

CAPSULE –5mm long, ovoid, acute, pointed With the style-base, glabrous. **SEED** – Ob Long, striate, pale, 0.85mm long.



Fig No. 3: Morphology of Bacopa Monnieri

PHARMACOLOGICAL ACTIVITY

Antiepileptic Activity

Fat-free alcohol extract It was discovered that "brahmi" was more effective than the aqueous form in reducing epileptic attacks. In one case of each temporal lobe epilepsy and petit mal epilepsy, the defatted alcoholic extract of "brahmi" showed improvement. In these two patients, there was a strong correlation between clinical improvement and EEG alterations. 31 adult patients with epilepsy between the ages of 23 and 42 received Mentat tablet formulation b.i.d. in addition to the other epileptic drugs for a period of six weeks. The incidence of seizures was greatly decreased by the Ayurvedic ingredients found in Mentat tablets, including B. monnieri, Centella asiatica, Whitania somnifera, Evolvulus alsinosides, and Nordostachys jatamanasi.

Antifungal Activity

Bacopa extract effectively suppressed the growth of the chosen fungus, as evidenced by the IC50 values for *Fusarium oxysporum* (31.25 g/ml), *Sclerotium rolfsii* (6.25 g/ml), *Alternaria* sp. (28.75 g/ml), and *Rhizoctonia solani* (18.75 g/ml) (Jain et al., 2017). The fungal toxicity of each *B. monnieri* extract was then evaluated against *Aspergillus flavus* and *Candida albicans*.

Anti-oxidant Activity

Free radicals can cause oxidative damage, which antioxidants help to stop. Free radicals can subject cells' homeostatic defense mechanisms to oxidative stress (Aguiar and Borowski, 2013). BME, or bacosides, have demonstrated antioxidant and anti-stress properties. According to a recent study, the GABAergic system may be involved in the modulation of these effects of BM on the central nervous system. Activity of Antioxidants: Using DPPH radical scavenging, the antioxidant capacity of four *B. monnieri* (whole plant) extracts was evaluated. The maximum antioxidant activity was found in the methanol and aqueous sequential extracts, with IC50 values of 46.00 g/ml and 43.10 g/ml, respectively (Kar et al., 2002). An alcoholic extract of *Bacopa monnieri* protected the liver from the effects of morphine-induced GSH depletion and antioxidant enzyme inhibition in rats.

Brahmi's antioxidants are crucial for promoting a healthy way of life. Free radicals are harmful byproducts of cellular metabolism that can cause cells to undergo apoptosis (cell death) or evolve into malignant cells. Antioxidants help remove free radicals.

Anti-ulcerative Activity

Bacopa monnieri juice and sucralfate were given orally twice daily for five days at doses of 100 and 300 mg/kg, respectively. According to Mohanty et al. (2010), the outcome is linked to factors that protect the mucosa, such as increased mucin secretion, decreased mucosal cell exfoliation, and mucosal glycoprotein. *Bacopa monnieri* whole plant fresh juice was examined using stomach ulcer models by Rao et al. in 2000. Aspirin and ethanol cause this.

Anti-Microbial activity

The anti-microbial efficacy of ethanolic, diethyl acetate, ethyl acetate, and aqueous extracts of aerial portions of *Bacopa monnieri* was assessed by Sampathkumar et al. (2008). Ethyl acetate extract demonstrated antibacterial action against gram-negative organisms, while diethyl ether extract demonstrated antibacterial activity against gram-positive organisms. Betulinic acid and orexin, two phytochemicals derived from the aerial portions of *Bacopa monnieri*, have been shown to exhibit antifungal effects on *Alternaria alternata* and *Fusarium fusiformis* (Sampathkumar et al., 2008). Compared to other extracts, methanol extracts were discovered to be the most effective antibacterial agents. None of the bacteria were active against aqueous extracts. Compared to methanol extracts, hexane and petroleum ether extracts demonstrated comparable antibacterial activity but were less potent.

Salmonella typhi, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Vibrio cholera*, and *Candida albicans* were the five bacteria and one fungus that the ether extract of *Bacopa monnieri* demonstrated antibacterial efficacy against. *Candida albicans* and *Aspergillus niger* were both resistant to the antifungal effects of the ethanolic extract. By using the disc diffusion method, it was demonstrated that *B. monnieri* extracts in ethyl acetate and methanol have antibacterial action against 7-gram-negative and 11-gram-positive bacteria (Khan et al., 2010).

Anti-convulsant Activity

Bacosides, a crude plant extract from *Bacopa monnieri*, have also demonstrated anticonvulsant properties. Several convulsive models, including pentylenetetrazol, maximal electroshock, strychnine-induced convulsions in rats, hypoxic stress-induced convulsions in mice, and lithium pilocarpine-induced status epilepticus, were used to test the ethanolic extract of *Bacopa monnieri* for anticonvulsant activity. With a mechanism of action resembling that of benzodiazepines (GABA agonists), the ethanolic extract of leaves demonstrated considerable anticonvulsant effects in all the different models investigated.

Anti-depressant activity

Bacopa monnieri has shown its potential as a potential anti-Parkinsonian drug by reducing alpha synuclein aggregation, preventing dopaminergic neurodegeneration, and restoring the lipid content in nematodes in

pharmacological Caenorhabditis elegans models of Parkinson's. Depression is a frequent and sometimes fatal illness. According to Singh and Dhawan (1997), patients with depression typically have a decline in brain neurotransmitters such as dopamine, serotonin, and norepinephrine. The Bacopa monnieri extracts significantly decreased the rats' plasma corticosterone level and escape delay while also exhibiting antidepressant properties.

Anti-diabetic activity

The metabolism of carbs, lipids, and proteins is impacted by the metabolic disorder known as diabetes mellitus. According to their investigation of an ethanolic extract of B. monnieri (Ghosh et al., 2011), the triterpene bacosine appears to be what causes the increased glycogen content in diabetic rats.

Anti-inflammatory activity

The substances released when the leaves of the brahmi plant are applied topically to the affected body areas might lessen swelling, soothe itchininess, and reduce inflammation inside the body as well. This is the best option for those who have gout, arthritis, or other inflammatory conditions, according to Singh and Dhawan (1997). By preventing the production of prostaglandins and in part by maintaining lysosomal membranes, bacopa monniera efficiently inhibited the experimentally produced inflammatory response effect and did not cause gastrointestinal irritation at anti-inflammatory doses. Prostaglandin synthesis and/or activity, as well as potential stabilization of lysosomal membranes, are all ways in which the drug's anti-inflammatory effectiveness is mediated. It shares Indomethacin's anti-inflammatory effects, according to Khanna (1995).

Anti-cancer activity

Bacopa monnieri alcoholic extract was referred to as an anti-cancer drug by Elangovan et al. in 1995. The ethanolic extract was tested using Sarcoma-180 cell culture. Cell growth was inhibited as the extract concentration rose. Ethanolic extracts and the saponin-rich fraction demonstrated anti-tumor efficacy, according to D'Souza et al. (2002). Bacoside-A is said to be the active element in charge of the anti-cancer impact. Additionally tested was the extract's capacity to kill brine shrimp.

Benefits Of Bacopa Monnieri

- Beneficial in providing relief from osteoporosis and arthritis.
- Provides relief from irritable bowel syndrome.
- Aids in treating breast prostate cancer.
- Helps to relieve respiratory system.
- Effective in treating skin disorders.
- Boosts immune system.
- Gives relief from stress and anxiety.
- Promotes sweating and helps to reduce fever.
- Stimulates urination and helps to keep kidneys healthy.

Table 3. List of Pharmacological Activities of Bacopa monnieri, Family: Scrophulariaceae

Name of plant	Part of plant	Extract	Activity	Dose	Inducing agent	Experimental Model	Chemicals	Reference
Bacopa monnieri	Whole plant	Bacoside E, Bacopasid VII	Anti-tumour	50mg/kg	-	Human tumour cell lines	-	[48]
	Whole plant	Ethanol extract	Anti-Alzheimer's	100mg/kg	-	Adult male rat	Ethanol	[49]
	Whole plant	Menthol extract	Anti-oxidant	10mg/kg	-	Rat brain	Menthol	[50]
	Whole	N -	Expression	15mg/kh	-	Mice	N -	[51]

	plant	Butanol extract	of morphine tolerance				Butanol	
	Whole plant	Alcohol	Neuroprotective	49mg/kg	-	Male Wister rat	Alcohol	[52]
	Leaf callus	Menthol extract	Anti-microbial	0.20mg/disc	-	Mice	Amino acid, Ascorbic acid	[53]
	Whole plant	Hexane	Anti-oxidant	10mg/kg	Ferrous sulphate	Rat brain	Alcohol, bacoside A	[54]
	Whole plant	Menthol extract	Anti-depressant	15mg/kg	Dopamine	Rat	Menthol	[55,56]
	Juice of plant	Menthol extract	Anti-ulcerative	250mg/kg	Ethanol, aspirin	Rat	Ethanol	[57]
	Whole plant	Menthol extract	Anti-inflammatory	200mg/kg	Histamine	Rat, Mice	Menthol	[58]
	Aerial part	Ethanol	Analgesic	250 to 500 mg/kg	-	Mice	Acetic acid	[59,60]
	Whole plant	Butanoic extract	Antiemetic	5 to 20 mg / kg	-	Mice or rat	Menthol	[61]
	Whole plant	Crude plant extract	Anti-convulsant	50 to 52 mg / kg	-	Mice and rat	-	[62,63]
	Whole plant	Menthol extract	Antihyperglycemic	10ml/kg body weight	-	Mice	Glacial acetic acid	[64]
	Whole plant	Ethanol	Gastrointestinal activity	500mg/kg	Loparamide	Mice	Ethanol	[65]
	Whole plant	Bacopa extract	Gastrointestinal activity	20mg/kg	-	Mice	-	[66]
	Whole plant	Bacoside A	Anti-apoptosis	10mg/kg/day	-	Adult male albino rat	-	[67]
	Whole plant	Bacoside A	Neuroprotective	10mg/kg/day	-	Rat	-	[68]
	Whole plant	Bacoside A	Hepatoprotective	15mg/kg	-	Rat brain	-	[69]
	Whole plant	Std.BM extract	Memory enhancer	250mg twice a day	-	Human brain	-	[70]
	Leaves	Ethanol extract	Anti-convulsant	50 to 55 mg/kg	Benzodiazepines	Mice	-	[71]
	Whole	Menthol	Anti-	100 mg/kg	Petroleum	Rat	-	[72]

	plant	extract	inflammatory		ether			
	Whole plant	Menthol extract	Anti-inflammatory	100 to 300 mg/kg	Triterpenoid bacosides	Mice	-	[73,74]
	Whole plant	Bacopa extract	Endocrine effect	200mg/kg	-	Mice	-	[75]
	Whole plant	Menthol and aqueous extract	Anti-oxidant	46.00ug/ml And 43.10ug/ml	-	Rat	-	[76,77]

II. CONCLUSION

One of the traditional plants used in Ayurveda and herbal remedies is bacopa. BM exhibits tremendous promise for treating a variety of neuropharmacological, depressive, inflammatory, and other illnesses. The therapeutic efficacy of Bacopa monnieri has been established by preclinical, clinical, and evaluation studies in many illness conditions, and it is widely utilized in Indian medicine. The ethanolic extract of BM demonstrated a considerable impact in the treatment of diabetes, a serious problem for the global community today.

III. REFERENCE

- [1] Singh, H.K. and B.N. Dhawan, Neuropsychopharmacological effects of the Ayurvedic nootropic Bacopa Monniera Linn.(Brahmi) Indian J Pharmacol.
- [2] Stough, C., H. Singh, and A. Zangara, Mechanisms, Efficacy, and Safety of Bacopa monnieri (Brahmi) For Cognitive and Brain Enhancement. Evid Based Complement Alternat Med.
- [3] Chaudhari, K.S., et al., Neurocognitive Effect of Nootropic Drug Brahmi (Bacopa monnieri) in Alzheimer’s Disease. Ann Neurosci.
- [4] Moran, C., et al., Type 2 diabetes mellitus, brain Atrophy, and cognitive decline. Neurology.
- [5] Irwin, K., et al., Healthy Aging and Dementia: Two Roads Diverging in Midlife? Front Aging Neurosci.
- [6] <https://www.planetayurveda.com/library/brahmi-bacopa-monnieri/>
- [7] <https://www.slideshare.net/mobile/aksharpreetpharmacy/brahmi-79124023>
- [8] Agnivesa, Charaka Samhita, Re-vised by Charaka and Drdhabala, Commentary by Pt.Kasinath Sastri And Dr.Gorakhanatha Chaturvedi, Re-print 2004, Varanasi, Chau- khamba Bharati Academy, Tpg-738.
- [9] Sushruta, Sushruta Samhita, with Nibandhasangraha commentary Of Dalhanacharya and Nyayachan- drika panjika of Gayadasacharya on Nidanasthana, Edited by jadavji Trikamji Acharya and Narayan Ram Acharya, re-print 2012, Varanasi, Chaukhambha Surbharati Prakashan, Tpg-824.
- [10] Uabundit, N.; Wattanathorn, J.; Mucimapura, S.; Ingkaninan, K. Cognitive enhancement and neuroprotective Effects of Bacopa monnieri in alzheimer’s disease model. J. Ethnopharmacol. 2010, 127, 26–31. [CrossRef][PubMed]
- [11] Dhanasekaran, M.; Tharakan, B.; Holcomb, L.A. Neuroprotective mechanisms of ayurvedic antidementia Botanical Bacopa monniera. Phytother. Res. 2007, 21, 965–969. [CrossRef] [PubMed]
- [12] Chaudhari, K.S.; Tiwari, N.R.; Tiwari, R.R.; Sharma, R.S. Neurocognitive effect of nootropic drug brahmi (Bacopa monnieri) in alzheimer’s disease. Ann. Neurosci. 2017, 24, 111–122. [CrossRef] [PubMed]
- [13] <http://www.theplantlist.org/tpl/record/kew-2667648>
- [14] https://en.m.wikipedia.org/wiki/Bacopa_monnieri.
- [15] <https://www.istockphoto.com/photos/bacopa-monnieri>
- [16] <http://www.flowersofindia.net/catalog/slides/Brahmi.html>
- [17] <http://www.ecoindia.com/flora/trees/brahmi-plant.html>
- [18] https://en.wikipedia.org/wiki/Bacopa_monnieri
- [19] <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7225932/#:~:text=monnieri%20contains%20alkaloid%20brahmine%2C%20nicotine,and%20pseudojuginin%20glycoside%20%5B7%5D>.

- [20] <https://healthjade.net/bacopa-monnier/>
- [21] Chaudhari, K. S., Tiwari, N. R., Tiwari, R. R., & Sharma, R. S. (2017). Neurocognitive Effect of Nootropic Drug Brahmi (*Bacopa monnieri*) in Alzheimer's Disease. *Annals of neurosciences*, 24(2), 111-122. <https://doi.org/10.1159/000475900>
- [22] *Bacopa monnieri*. Monograph. *Alt Med Rev* 2004; 9:79-85
- [23] Jain Paras., Sharma., Hanuman Prasad., Basri. Fauziya., Kumari, Priya. And Singh Pallavi. 2017. Phytochemical analysis of *Bacopa monnieri* (L.) Wettst and their anti-fungal activities, *Experiment Findings*,16(2): 310-318.
- [24] <https://arxiv.org/pdf/1909.01856>
- [25] Bhakuni DS, Dhar ML, Dhar MM, Dhawan BN, Mehrotra BN. Screening of Indian plants for biological activity. II. *Indian J Exp Biol* 1969;7(4):250-62.
- [26] Rao CV, Sairam K, Goel RK. Experimental evaluation of *Bocopa Monniera* on rat gastric ulceration and secretion. *Indian J Physiol Pharmacol* 2000;44(4):435-41.
- [27] Govindarajan R, Vijayakumar M, Pushpangadan P. Antioxidant Approach to disease management and the role of 'Rasayana' herbs of Ayurveda. *J Ethnopharmacol* 2005;99(2):165-78.
- [28] Singh HK, Dhawan BN. Neuropsychopharmacological Effects of the Ayurvedic nootropic *Bacopa monniera* Linn. (*Brahmi*)". *Indian J Pharmacol*. 1997; 29:359-365.
- [29] Sumathy T, Subramanian S, Govidasamy S and Balakrishna KG. Protective role of *Bacopa monniera* on morphine induced Hepatotoxicity in rats. *Phytoether Res* 2001; 15: 643-645.
- [30] Kar, A., Panda, S and Bharti, S. 2002. Relative efficacy of three medicinal plant extracts in the alteration of thyroid hormone Concentrations in male mice. *Journal of Ethnopharmacology*, 81: 281-285.
- [31] Aguiar S and Borowski T (2013) Neuropharmacological review of The nootropic herb *Bacopa monnieri*. *Rejuvenation Res* 16:313-326. DOI: 10.1089/rej.2013.1431
- [32] Mohanty, I.R., Maheshwari, U., Joseph, D. and Deshmukh, Y. 2010. *Bacopa monniera* protects rat heart against ischaemia-Reperfusion injury: role of key apoptotic regulatory proteins and enzymes. *Journal of Pharmacy and pharmacology*, 62(9): 1175-1184.
- [33] Rao CV, Sairam K, Goel RK (2000) Experimental evaluation of *Bacopa monniera* on rat gastric ulceration and secretion. *Indian J Physiol Pharmacol* 4: 435-441.
- [34] Sampathkumar P, Dheeba B, Vidhyasagar ZV, Arulprakash T, Vinothkannan R (2008) Potential Antimicrobial Activity Of Various Extracts of *Bacopa monnieri* (Linn.). *Int J Pharmacol Research* 4: 230-232. DOI: 10.3923/ijp.2008.230.232
- [35] Azad AK, Awang M, Rahman MM. Phytochemical and microbiological evaluation of a local medicinal plant *Bacopa monnieri* (L.) Penn. *International Journal of Current Pharmaceutical Review and Research* 2012;3(3), 66-78.
- [36] Reas SK, Ameer K and Paulose CS. Glutamate receptor gene expression and binding studies in pilocarpine induced epileptic rat: role of *Bacopa monnieri* extract. *Epilep Behav* 2008, 12:54-60.
- [37] Kaushik D, Tripathi A, Tripathi R, Ganachari M and Khan SA. Anticonvulsant activity of *Bacopa monniera* in rodents. *Brazilian Journal of Pharmaceutical Sciences* 2009; 45n: 643-649.
- [38] Sairam K, Dorababu M, Goel RK, Bhattacharya SK. Antidepressant activity of standardized extract of *Bacopa monniera* in Experimental models of depression in rats. *Phytomedicine* 2002; 9:207-211.
- [39] Zhou Y, Shen YH, Zhang C and Su J. Triterpene saponins from *Bacopa monnieri* and their antidepressant effects in two mice models. *J Nat Prod* 2007; 70(4): 652-655.
- [40] Singh HK, Srimal RC, Srivastava AK, Garg NK and Dhawan BN Proceedings of the fourth conference on the neurobiology of Learning and memory, California 17-20 October,1990:79.
- [41] Hazra S, Banerjee R, Das BK, Ghosh AK, Banerjee TK, Hazra US, Biswas SK, Mondal AC (2012) Evaluation of Antidepressant activity of *Bacopa monnieri* in rat: a study In animal model of depression. *Drug Discov* 2: 8-13.
- [42] Sabina, E.P., Baskaran, U.L., Martin, S.J. Swaminathan, M., Bhattacharya, Y. and Tandon, S., 2014. Assessment of Antidiabetic activity of the traditional Indian ayurvedic formulation Brahmi gritham in streptozotocin-induced diabetic Rats. *International Journal of Pharmacy and Pharmaceutical Sciences*, 6: 347-351.

- [43] Jain P, Khanna.NK, Trehan T, Pendse VK and Gohwani JL. Anti-inflammatory effects of an ayurvedic preparations, Brahmi Rasayan,in rodents. *Indian J Exp Biol* 1994; 32: 633-636.
- [44] Singh HK, Dhawan BN. Neuropsychopharmacological Effects of the Ayurvedic nootropic *Bacopa monniera* Linn. (Brahmi)". *Indian J Pharmacol.* 1997; 29:359-365.
- [45] Khanna, H.K. 1995. Studies on anti-inflammatory effects of Brahmi rasayan in rodents. *Indian Journal of Pharmacology*, 27:49.
- [46] D'Souza P, Deepak M, Rani P, Kadamboor S, Mathew A (2002) Chandrashekar AP, Agarwal A, Brine shrimp lethality Assay of *Bacopa monnieri*. *Phytotherapy Res* 16: 197-198. DOI: 10.1002/ptr.1001.
- [47] Elangovan V, Govindasamy S, Ramamoorthy N, Balasubramanian K (1995) In vitro studies on the Anticancer activity of *Bacopa monnieri*. *Fitoterapia* 66:211-215.
- [48] Peng, L.; Zhou, Y.; de Kong, Y.; Zhang, W.D. Antitumor activities of dam- marane triterpene saponins From *Bacopa monniera*. *Phytother. Res.* 2010, 24, 864–868. [PubMed].
- [49] Ahirwar, S.; Tembhre, M.; Gour, S.; Namdeo, A. Anticholinesterase efficacy of *Bacopa monnieri* Against the Brain regions of rat—a novel approach to therapy for Alzheimer's disease. *Asian J. Exp. Sci.* 2012, 26, 65–70.
- [50] Anbarasi, K.; Vani, G.; Balakrishna, K.; Devi, S.C.S. Creatine kinase isoenzyme patterns upon chronicExposure to cigarette smoke: Protective effect of bacoside A. *Vasc. Pharm.* 2005, 42, 57–61. [CrossRef][PubMed]
- [51] Rauf, K.; Subhan, F.; Abbas, M.; Badshah, A.; Ullah, I.; Ullah, S. Effect of bacosides on acquisition And Expression of morphine tolerance. *Phytomedicine* 2011, 18, 836–842. [CrossRef] [PubMed]
- [52] Uabundit, N.; Wattanathorn, J.; Mucimapura, S.; Ingkaninan, K. Cognitive enhancement and Neuroprotective Effects of *Bacopa monnieri* in Alzheimer's disease model. *Journal of Ethnopharmacology.* 2010, 127, 26–31. [CrossRef]
- [53] Bauer AW, Kirby WM, Sherris JC, Turck M. Antibiotic susceptibility testing by a Standardized single disk Method. *Am. J. Clin. Path.* 1966, 45, 493.
- [54] Anbarasi K, Vani G, Balakrishna K, Devi CS (2006) Effect of bacoside-A on brain antioxidant status in Cigarette smoke exposed rats. *Life Sci* 78: 1378-1384. DOI: 10.1016/j.lfs.2005.07.0
- [55] Hazra S, Banerjee R, Das BK, Ghosh AK, Banerjee TK, Hazra US, Biswas SK, Mondal AC (2012) Evaluation of Antidepressant activity of *Bacopa monnieri* in rat: a study In animal model of depression. *Drug Discov* 2: 8-13.
- [56] H.K. Singh, B.N. Dhawan (1997) Neuropsychopharmacological Effects of the Ayurvedic Nootropic *Bacopa monniera* Linn. (Brahmi). *Indian J Pharmacol* 29: 359–S365.
- [57] Rao CV, Sairam K, Goel RK (2000) Experimental evaluation of *Bacopa monniera* on rat gastric Ulceration and secretion.*Indian J Physiol Pharmacol* 4: 435-441.
- [58] Kumar S, Bajwa BS, Kuldeep S, Kalia AN (2013) Anti-Inflammatory activity of herbal plants: A review. *Int J Adv Pharm Biol CChem* 2: 272-281.
- [59] Vohora SB, Khanna T, Athar M, Ahmad B (1997) Analgesic Activity of bacosine, a new triterpene Isolated from *Bacopa Monnieri*. *Fitoterapia* 68: 361-365.
- [60] Siraj MA, Chakma N, Rahman M, Malik S, Sadhu SK (2012) Assessment of analgesic, antidiarrhoeal And cytotoxic Activity of ethanolic extract of the whole plant of *Bacopa Monnieri* Linn. *Int Res J Pharm* 3: 98-101.
- [61] Ullah, I., Subhan, F., Lu Z., Chan S., W. and Rudd JA. 2017. Action of *Bacopa monnieri* to antagonize Cisplatin-induced Emesis in *Suncus murinus* (house musk shrew). *Journal of Pharmacological Sciences*, 133(4) 232–239.
- [62] Singh HK, Shanker G, Patnaik GK. Neuropharmacological and anti-Stress effects of bacosides: A Memory enhancer. *Indian J Pharmacol* 1996;28:47.
- [63] Bhattacharya SK, Ghosal S. Anxiolytic activity of a standardized Extract of *Bacopa monniera*: An Experimental study. *Phytomedicine* 1998;5(2):77-82
- [64] Venkatesh S, Reddy, GD, Reddy YSR, Sathyavathy D and Reddy BM (2004). Effect of *Helicteres isora* Root Extracts on glucose tolerance in glucose-induced Hyperglycemic rats. *Fitoterapia*, 75: 364-367

- [65] Ajalus, S.M.; Chakma, N.; Rahman, M.; Salahuddin, M.; Kumar, S.S. Assessment of analgesic, Antidiarrheal And cytotoxic activity of ethanolic extract of the whole plant of *Bacopa monnieri* Linn. *Int. Res. J. Pharm.* 2013, 3, 98–101.
- [66] Subhan, F.; Abbas, M.; Rauf, K.; Arfan, M.; Sewell, R.D.; Ali, G. The role of opioidergic mechanism in The activity of *Bacopa monnieri* extract against tonic and acute phasic pain modalities. *Pharmacologyonline* 2010, 3, 903–914
- [67] Anbarasi, K.; Kathirvel, G.; Vani, G.; Jayaraman, G.; Devi, S.C.S. Cigarette smoking induces heat shock Protein 70 kDa expression and apoptosis in rat brain: Modulation by bacoside A. *Neuroscience* 2006, 138, 1127–1135.[CrossRef]
- [68] Anbarasi, K.; Sabitha, K.E.; Devi, C.S.S. Lactate dehydrogenase isoenzyme patterns upon chronic Exposure To cigarette smoke: Protective effect of bacoside A. *Environ. Toxicol. Pharmacol.* 2005, 20, 345–350. [CrossRef]
- [69] Janani, P.; Sivakumari, K.; Parthasarathy, C. Hepatoprotective activity of bacoside A against N-Nitrosodiethylamine-induced liver toxicity in adult rats. *Cell Biol. Toxicol.* 2009, 25, 425–434. [CrossRef]
- [70] Raghav, S.; Singh, H.; Dalal, P.K.; Srivastava, J.S.; Asthana, O.P. Randomized controlled trial of Standardized *Bacopa monniera* extract in age- associated memory impairment. *Indian J. Psychiatry* 2006, 48, 238–242.
- [71] Kaushik D, Tripathi A, Tripathi R, Ganachari M and Khan SA. Anticonvulsant activity of *Bacopa monniera* in rodents. *Brazilian Journal of Pharmaceutical Sciences* 2009; 45n: 643-649.
- [72] Mathur A, Verma SK, Purohit R, Singh SK, Mathur D, Prasad G and Dua VK. Pharmacological investigation of *Bacopa monnieri* on The basis of antioxidant, antimicrobial and anti-inflammatory properties. *J Chem Pharm. Res* 2010, 2(6):191-198
- [73] Sundriyal A, Rawat DS and Singh AK. Tissue culture, phytochemical and pharmacological study of *Bacopa monnieri*. *Asian Journal Of Biochemical and Pharmaceutical Research* 2013;1(3): 243-260.
- [74] Viji V and Helen A. Inhibition of pro-inflammatory mediators: role of *Bacopa monniera* (L.) Wettst, *Inflammo pharmacology* 2010.
- [75] Kar A, Panda S and Bharti S. Relative efficacy of three medicinal plant extracts in the alteration of thyroid hormone concentrations in Male mice. *J Ethnopharmacol* 2002;81: 281-285.
- [76] Sumathy T, Subramanian S, Govidasamy S and Balakrishna KG. Protective role of *Bacopa monniera* on morphine induced Hepatotoxicity in rats. *Phytoether Res* 2001; 15: 643-645.
- [77] Mathur A, Verma SK, Purohit R, Singh SK, Mathur D, Prasad G and Dua VK. Pharmacological investigation of *Bacopa monnieri* on The basis of antioxidant, antimicrobial and anti-inflammatory properties. *J Chem Pharm. Res* 2010, 2(6):191-198.